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LAW OF REFRACTION—CHANGE FOLLOWING INCREASE OR DECREASE OF BODY-WEIGHT.

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*LAW OF REFRACTION-CHANGE FOLLOWING  
INCREASE OR DECREASE OF BODY-  
WEIGHT.<sup>1</sup>*

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IN starvation, ninety-seven per cent. of the fat of the body is lost before death, and of the remaining three per cent. the orbits always retain some and a larger amount proportionately than other localities. This seems to indicate that the cushion of fat blanketing the eyeball posteriorly is of great importance to the function of vision, and if so, it would appear natural that great increase or decrease of body-weight, consisting mostly in gain or loss of fat, might lead to changes of fat-deposits in the orbit, with consequent variations in pressure upon the eyeball. If to this consideration we add the noteworthy fact that a variation so small as that of one millimeter in the anteroposterior diameter of the eyeball produces the huge ametropic change of three diopters, we recognize how slight a difference in orbital pressure is required to account for a marked variation of refractive error. It is easily demonstrable that a difference of one or two diopters may be produced simply by increase or decrease of posterior pressure, without posterior staphyloma or in any way altering the total capacity of the eyeball, but simply by altering its shape. The equatorial diameter would be

<sup>1</sup> Read at the Thirty-third Annual Meeting of the American Ophthalmological Society, held at Washington, D. C., May 4, 5, and 6, 1897.

lengthened by a slight polar shortening, and *vice-versa*. The ametropia of albinotic eyes shows this fact produced by another mechanism.

These purely *a priori* thoughts had been in mind for years, and I had had a number of patients in whom changes of refraction were suspected to be co-incident or consequent upon changes in body-weight, but there were always some elements of doubt, due to the fact that as the patients had been previously examined by other oculists, I might reasonably suspect they were errors due to my own carelessness, etc. Last spring, however, several cases came nearly together, and a study of the case-records appeared to warrant a tentative theory, or working hypothesis, of sufficient plausibility to justify making the suggestion public. I remember to have been often perplexed before the present suggestion occurred to me to account for decreases in myopia. I, by no means, claim any great definiteness of result or any precise formulation of a law, except in general terms, and liable to modifications and exceptions. I myself have had one or two cases showing that, if founded upon fact, the rule is not invariable. It certainly could not be so, because many complicating conditions and circumstances must occur and must be taken into account. With all due allowances and justifiable cautions it seems to me that the thought is a reasonable one, and is given in order to be proved or disproved by the future observations of many. If it is true it will help to explain a number of perplexing cases, and put us and our patients on guard. I am sure the common belief that myopia does not lessen is frequently disproved by facts. It

has for years been my custom to expect refraction-changes consequent upon severe general illness, and it may be that these are, at least in part, mere corollaries of the theory under consideration.

In brief my suggestion is as follows: Great increase of body-weight may cause shortening of the anteroposterior diameter of the eyeball or alterations of curvature (increase of hyperopia, decrease of myopia, or similar changes of astigmatism); and on the other hand, great decrease of body-weight may be coincident with lengthening of the eyeball (decrease of hyperopia, increase of myopia, or like changes of astigmatism).

A few cases<sup>1</sup> clinically illustrating this law, if it may be so called, are as follows:

*Case 3125.*—The patient was a man of twenty-five, and was first examined March 11, 1894, with the following finding:

R.—Cyl. 0.25 ax. 20°; L.—Sph. 5.50—Cyl. 0.50 ax. 160°. On March 22, 1897, I again tested the error, finding: R.—Cyl. 0.37 ax. 105°; L.—Sph. 4.75=Cyl. 0.25 ax. 160°.

Since the first examination he had gained about thirty pounds in weight, and the refraction-changes were in the right eye 0.62 D., and in the left 1.25 D. The case seems noteworthy because the change was twice as great in the highly myopic eye.

*Case 4034.*—The patient was a man of thirty-two, and was examined in 1889 by an oculist whose record I can trust, and who prescribed:

R.—Sph. 4.00—Cyl. 1.00 ax. 165°; L.—Sph. 1.25—Cyl. 1.00 ax. 90°. In 1895 I found: R.—Sph. 3.50=Cyl. 1.00 ax. 160°; L.—Cyl. 2.50 ax.

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<sup>1</sup> All, of course, tested under mydriasis.

90°. On March 24, 1896, I found: R.—Sph. 2.75—Cyl. 1.25 ax. 180°; L.—Cyl. 2.25 ax. 90°.

During these seven years the patient had steadily gained in weight a total of about forty pounds. In this case it was the highly myopic eye that had decreased in myopia a total of at least one diopter, the left remaining comparatively unchanged.

*Case 1493.*—A woman of twenty-five was refracted in 1891, and the following error was found:

R.—Sph. 5.50—Cyl. 1.00 ax. 5°; L.—Sph. 5.50—Cyl. 1.00 ax. 5°. In 1887 the error was found to be: R.—Sph. 4.75—Cyl. 1.12 ax. 5°; L.—Sph. 4.75—Cyl. 1.37 ax. 5°.

In the meantime she had gained about thirty pounds in weight, the coincident loss of myopia being about 0.50 D.

*Case 4280.*—Miss. B., eighteen years of age, was refracted April 18, 1896, and found to have the following error of refraction:

R.—Sph. 0.24+Cyl. 0.50 ax. 75°; L.—Sph. 0.25+Cyl. 0.62 ax. 105°. On April 24, 1897, the refraction was found to be as follows: R.+Sph. 0.50+Cyl. 0.50 ax. 75°; L.+Sph. 0.25+Cyl. 0.75 ax. 90°.

During the year she had gained very much in health and flesh, but just how much the increase in weight was it is impossible to say.

*Case 4074.*—A boy of thirteen was first refracted in November, 1895. At this time he was of normal height, but very fat, weighing about 150 pounds. On February 19, 1897, he returned, complaining that he could not see the blackboard and other distant objects as plainly as formerly. Upon inquiry, the mother said that these complaints had been growing more frequent and more pronounced during the past two or three months, during which hygiene and dietary measures had been enforced to reduce his flesh. The treatment had been so successful

that during this time he had lost about fifty pounds in body-weight, and in girth the waist had fallen from  $39\frac{1}{2}$  inches to  $34\frac{1}{2}$  inches. At the same time his height had decidedly increased, the lessening of fat having been followed by a rapid gain in body-length. (There is considerable indefiniteness as to the weight and height, but I secured from his tailor the waistband measurements.)

His refraction in 1895 was:

R. and L. the same—Sph. 0.25+Cyl. 0.75 ax.  $90^\circ$ . Fifteen months later it was: R.—Sph. 0.25—Cyl. 0.75 ax.  $180^\circ$ ; L.—Sph. 0.25—Cyl. 0.87 ax.  $180^\circ$ .

Thus there was a total change of refraction of fully two diopters accurately synchronous, with the loss of flesh. Up to the time of "going to press" there has been no noteworthy change in refraction, though I have re-examined the eyes several times.

I could cite other cases apparently of the same kind, but these seem sufficiently illustrative of the theory suggested to stimulate the observation of others. It is also possible that changes in muscle-balance may sometimes depend upon the amount of fat in the orbits and lids. An indirect but striking proof of the theory set forth consists in the fact of the production of high degrees of compound hyperopic astigmatism in albinos due to the continuous lid-pressure. The albino seeks to shut out light by the lids, and the pressure lessens the anteroposterior diameter of the cornea and shortens the vertical meridian to an enormous degree.





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